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# Should Japanese tax system be more progressive?*

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**Abstract**

We investigate the effects of marginal changes of marginal tax rates of Japanese income tax system, computing the social marginal costs of public funds (SMCF) generated by marginal increase in tax rates. We use large micro data sets on Japanese households, and estimate a structural discrete choice model of household labor supply. Our estimation results show that the average of total elasticity of males ranges between 0.0276 and 0.0521, and that of female between 0.0429 and 0.2134. Based on the estimated utility functions, we find that SMCF for raising the marginal tax rate applied for those with low- or medium-income level is smaller than those with more income. Our results could suggest Japanese income tax system should be less progressive.

*JEL*: H21, H24, H31, J22

*Key Words*: Social marginal cost of public funds; structural discrete choice model; household labor supply.

## 1 Introduction

Many industrial countries had seen their income tax system made flatter since 1970s until recently. Japan is no exception. The Japanese government decreased the number of brackets and lowered the top marginal tax rate in a series of tax reform from the late 1970s to the mid-2000s. The key words for the series of tax reductions included "incentives to work" and "neutrality

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(no distortion)". Recent arguments tend to put emphasis on distributional aspects. In any case, design of optimal income taxation requires information on household's responses to tax system. However, in contrast to the rich stock of empirical studies on the labor supply response to taxation for North America and Europe, few analogous attempts have been made in Japan. This paper tries to fill this gap and investigate a desirable direction of marginal reform of Japanese income tax system, computing the social marginal costs of public funds (SMCF).

The development of optimal tax theory enables us to derive an optimal tax schedule based on distribution of ability and elasticity of labor supply or taxable income (Diamond 1998, Saez 2001). There has been a surge of empirical research on effects of taxation on labor supply behavior (Blundell and MaCurdy 1999, Meghir and Phillips 2010, Keane 2010) and marginal cost of public funds (e.g., Dahlby 2008).

The purpose of this paper is to examine a desirable direction of marginal reform of Japanese income tax system, using large micro data. To do so we estimate a structural discrete choice model of household labor supply, following van Soest (1995), and calculate SMCFs created by marginal changes in tax parameters, particularly, national marginal tax rates. If an SMCF for raising a tax rate is higher than another tax rate, the pair of the SMCFs indicates that the former rate should be reduced relative to the latter under the standard conditions, since an optimal set of tax rates requires their MCFs to be equalized.

The contributions of this paper are twofold. One is to estimate the labor supply elasticity with respect to after-tax wage rate for Japanese households. As mentioned above, there does not seem to be a rich stock of empirical research on this topic in Japan (Bessho and Hayashi 2005). The literature points out the distinction between the intensive and extensive margin, we introduce a fixed cost for participating labor market and estimate two types of elasticities along the intensive and extensive margin. The other contribution is to provide SMCF estimates for four marginal tax rates of the national income tax system. Because we have already had the income tax system and cannot scrap the current system to start over again to design a new tax system, we believe the importance of consideration of marginal tax reform.

Our estimation results show that the average of total elasticity of males ranges between 0.0276 and 0.0521, and that of females between 0.0429 and 0.2134, which is quite consistent with the counterparts of North America and Europe. Using these estimated parameters, we find that the SMCFs for increase in the marginal tax rate of the lowest bracket is smallest, except for the top bracket, when taking the number of household members into account. This suggests that in our setting the marginal tax rates of the lowest bracket should be raised before those of higher brackets are increased.

The rest of this paper proceeds as follows. Section 2 presents our model of labor supply behavior, and the specification is described in detail in Section 3. We explain our data set in Section 4. Section 5 shows the results, and Section 6 concludes.

## 2 The model

Household is either a single or nuclear household. Here we describe an optimization problem of a nuclear household, but that of a single household is set in a similar way.

Household $i$ consumes a numeráire $x_i$ and leisure of husband $l_{hi}$ and wife $l_{wi}$ to obtain utility $u_i = u_i(x_i, l_{hi}, l_{wi})$. [(1)] We assume a collective model in the sense that household members jointly maximize the utility, $u_i$, given the before-tax wage rate and tax codes. The time endowment is expressed as $T$ so that husband's labor supply is given as $h_{hi} = T - l_{hi}$, and wife's as $h_{wi} = T - l_{wi}$. $x_i$ is equal to the family's after tax income, including husband's and wife's earnings. Denoting the parameters of income tax code as $\tau$, the family's after income tax income is represented as:

$$x_i = [W_{hi}h_{hi} - T(W_{hi}h_{hi}, W_{wi}h_{wi}; \mathbf{Z}_i, \tau)] + [W_{wi}h_{wi} - T(W_{wi}h_{wi}, W_{wi}h_{wi}; \mathbf{Z}_i, \tau)] \tag{1}$$

where $T(\cdot)$ is a income tax function, $\mathbf{Z}_i$ is a vector of the family's characteristics and $W_{hi}$ and $W_{wi}$ are pre-tax wage rate of husband and wife, respectively. Note that husband's (wife's) income tax depends on wife's (husband's) income in Japan through, for example, allowance for spouses. Because the family's utility depends on the tax code, we can write the utility as $u_i = u(x_i, l_{hi}, l_{wi}; \mathbf{Z}_i, \tau)$.

The social welfare in the society is represented by the social welfare function of the Bergson-Samuelson type, $S = S(\mathbf{u})$, where $\mathbf{u} = \{u_i\}$ is a vector of utilities of all of the individuals in this society. The social marginal cost of public funds (SMCF) is defined as a reduction in the social welfare caused by a unit increase in tax revenue, $R$, also dependent on the tax code. SMCF depends on how the marginal tax revenue is financed. When the unit increase is financed by a change in a parameter $\tau_k$, an element of $\tau$, SMCF is defined as:

$$\mathrm{SMCF}_{\tau_k} \equiv -\frac{dS}{dR} = -\frac{\partial S/\partial \tau_k}{\partial R/\partial \tau_k}. \tag{2}$$

If the tax code is set optimally, $\mathrm{SMCF}_{\tau_k}$ should be the same for all $k$ (Dahlby 2008, p.23). If $\mathrm{SMCF}_{\tau_k} > \mathrm{SMCF}_{\tau_m}$, then the parameter $\tau_k$ should be raised and $\tau_m$ be lowered. Denoting the

[(1)]We follow Dahlby (1998) to set aside the revenue effect of public services in calculating MCF, and leave it to the benefit side of project evaluation.We therefore set the level of public service fixed in our analysis so that it does not appear in our expression of utility function.

individual marginal cost of public funds for household $i$ created from a reduction in family's welfare due to an increase in taxes imposed as $\text{MCF}_i = -(\partial u_i/(\partial v_i/\partial y_i))/dR_i$, where $\partial v_i/\partial y_i$ is a marginal utility of income, SMCF can be decomposed into three components as:

$$\text{SMCF}_{\tau_k} = \sum_i \beta_i \cdot \frac{dR_i}{dR} \cdot \text{MCF}_i \tag{3}$$

where $\beta_i$ is the marginal social welfare of household $i$'s income, which is also called the distributional weight. This decomposition articulates that the SMCF is the twice-weighted sum of individual MCFs.

In this paper, the tax function $T(\cdot)$ is sufficiently complex, thus marginal changes are approximated and simulated by small changes in tax code from $\tau^0$ to $\tau^1$. For example, change in utility is computed as $u_i(\cdot;\cdot,\tau^1) - u_i(\cdot;\cdot,\tau^0)$.

# 3 Specification

We apply a structural discrete choice household labor supply model following van Soest (1995). Each nuclear household is assumed to choose among the alternatives in the choice set of income leisure combinations $\{(x_{ij}, l_{hij}, l_{wij}) : j = 1, 2, ..., J\}$ to maximize $u(x_i, l_{hi}, l_{wi}; \mathbf{Z}_i, \tau)$. We work with the standard quadratic specification of the direct utility function:

$$\begin{aligned} u(\cdot;\cdot) \quad = \quad & \delta_x x_{ij} + \delta_h l_{hij} + \delta_w l_{wij} + \delta_{xx} x_{ij}^2 + \delta_{hh} l_{hij}^2 + \delta_{ww} l_{wij}^2 + \delta_{xh} x_{ij} l_{hij} + \delta_{xw} x_{ij} l_{hij} + \delta_{hw} l_{hij} l_{wij} \\ & + \delta_{hf} \mathbf{1}(h_{hij} > 0) + \delta_{wf} \mathbf{1}(h_{wij} > 0) + e_{ij} \end{aligned} \tag{4}$$

where $e_{ij}$ is an additive random disturbance and $\delta$s are coefficients to be estimated. The two terms, $\delta_{hf}\mathbf{1}(h_{hi} > 0)$ and $\delta_{wf}\mathbf{1}(h_{wi} > 0)$, reflect the fixed cost of working, thus the expected signs of $\delta_{hf}$ and $\delta_{wf}$ are negative. We assume here the two coefficients, $\delta_h$ and $\delta_w$, are dependent on the family's characteristics, $\mathbf{Z}_i$, which is common in the literature. The random disturbance, $e_{ij}$, follows the type I extreme value distribution identically and independently. Because the family choose $j$ for which the utility is the largest, we can use the multinomial logit model to estimate $\delta$s (van Soest 1995, Creedy and Kalb 2005).

In a single household case, the direct utility function is written using a similar notation:

$$u(\cdot;\cdot) \quad = \quad \gamma_x x_{ij} + \gamma_l l_{ij} + \gamma_{xx} x_{ij}^2 + \gamma_{ll} l_{ij}^2 + \gamma_{xl} x_{ij} l_{ij} + \gamma_f \mathbf{1}(h_{ij} > 0) + e_{ij} \tag{5}$$

where $l_i$ is leisure of the household, $h_i$ is labor supply, and $\gamma$s are coefficients. The coefficient, $\gamma_l$, is assumed to be dependent on the household's characteristics, $\mathbf{Z}_i$.

We calculate labor supply elasticity with respect to gross (before-tax) wage rate. Following the literature, we define a days-of-work elasticity along the intensive margin, $\varepsilon_i$, a participation elasticity along the extensive margin, $\eta_i$, and a total elasticity, $\varepsilon_i + \eta_i$:

$$\varepsilon_i = \frac{\partial E[h_i|h_i > 0]}{\partial W_i} \frac{W_i}{E[h_i|h_i > 0]}, \quad \eta_i = \frac{\partial p(h_i > 0)}{\partial W_i} \frac{W_i}{p(h_i > 0)} \tag{6}$$

Since both husband and wife can work in this setting, we calculate "cross" elasticity, husband's labor supply elasticity with respect to wife's gross wage rate and wife's elasticity with respect to husband's gross wage rate, as well, for nuclear families. The expectation is taken over the random disturbance, $e_{ij}$.

Three variants for the distributional weights, $\beta_i$, are considered in this paper. First, we set $\beta_i = 1$ for all $i$. In this case we ignore the number of household members, although our sample consists of both single and nuclear families. The second and third variants take the numbers of household members into consideration. In the second case $\beta_i$ is assumed to be the same as the number of household members ($\beta_i = n_i$), while $\beta_i$ is the square root of the number in the third case ($\beta_i = \sqrt{n_i}$). The square root is often used for computation of adult equivalence. Since neither family's utility nor income is taken into account, one may say that we are not considering "distributional" concerns. However, because the social welfare function is subjective and basically unobservable, we believe that it is interesting to consider the case where we disregard distributional concerns (in a narrow sense) and focus entirely on the efficiency aspect, as discussed in Kleven and Kreiner (2006, p.1962). Therefore, our measure of SMCF is:

$$\text{SMCF}_{\tau_k} = \sum_i \beta_i \frac{\Delta E[R_i]}{\Delta E[R]} \cdot \frac{\Delta E[u_i]/(\partial E[v_i]/\partial y_i)}{\Delta E[R_i]}, \tag{7}$$

where $\partial E[v_i]/\partial y_i$ is computed as $\Delta E[u_i]/\Delta x_i$.

Our model is based on a standard and static model, putting emphasis on the progressive structure of labor income taxes and paying scant attention to some issues discussed already in the literature. First, we do not consider an intertemporal decision makings (e.g, MaCurdy 1983). Second, we assume that family members jointly maximize the utility, ignoring interactions among them. Third, our model is premised on the perfect knowledge of families about complicated tax codes. Fourth, tax evasion is not taken into consideration.

# 4 Data

## 4.1 Sample

The data used in the sample are from *Syugyo Kozo Kihon Chosa* [Employment Status Survey] conducted by the Statistical Bureau of the Japanese Government in 2002. This survey is conducted every five years and the most comprehensive labor survey in Japan: it produces a large sample that contains about 11 million individual observations with a variety of household characteristics. We focused on the labor supply of nuclear families whose heads are prime age (25-55) males and single households with the same ages. We omitted the following observations from the sample: (a)self-employed workers, (b) board's members of private companies and non-profit organization, (c) family workers for SMEs, (d) the unemployed due to illness, (e) those who had changed residence or job within one year, and (f) those who had children within one year. These omissions reduces the sample size down to 52,706, i.e., 39,616 (nuclear families) plus 13,090 (single households).

Our labor supply measure is days worked in a year, which is provided as an interval data in the survey. Following the interval, we assume that husband and wife choose from seven alternatives, $\{0, 25, 75, 125, 175, 225, 275\}$. The choice set thus contains $7^2 = 49$ points for nuclear families and 7 points for single households.

The variables included in $\mathbf{Z}_i$ are standard in the literature. They consist of age dummies, the number of children below 15 years old, the number of dependents other than said children, residence (metropolitan dummy) and education dummies. In case of single households we add a dummy variable for female households.

## 4.2 Before-tax wage rate

We use as before-tax wage rate predicted values. Since the data for days worked and labor income are provided as intervals, we first calculate before-tax wage rate as quotient of middle values of days worked and labor income. The predicted before-tax wage rate is defined as a fitted value of a wage rate regression for each gender and household type (nuclear or single household) where the dependent variable is log of the before-tax wage rate and the explanatory variables include dummies for age, residence, education and their cross term. Since non-negligible portion of wives choose zero days worked, the wage rate regression for females is estimated by Heckit sample selection model, where excluded instruments are quadratic terms of residuals obtained from a regression for non-labor income (family income minus husband's labor income in case of nuclear family).

### 4.3 Tax code

To estimate the direct utility function, we need to know the family budget set by computing family's after-tax income, $x_{ij}$, for each alternative in the choice set. The amount of income tax for each individual is calculated as follows (see Table 1). Income tax on individuals include "income tax", a national tax, and "inhabitants tax", a local tax[(2)] and "social security premium", as a payroll tax. The principle to compute the amount of tax is almost the same between income tax and inhabitants tax. First, we derive "employment income " as the salaries the individual receives minus "employment income deduction". Second, "taxable income " is defined as the "employment income" minus some kinds of deductions and allowances, plus taxable non-labor income.[(3)] Finally, we apply the tax rates to taxable income and subtract some tax credits, if any, to obtain the tax amounts. In FY2002, there is the proportional tax credit with upper bound for income tax and inhabitants tax.

[Table 1 here]

The available deductions, allowances or tax credits differ as individual characteristics differ. Thus, we cannot take into account some of them because of data limitation. What we employ are basic allowance, allowance for spouses, special allowance for spouses, allowance for dependents, employment income deduction and deduction for social insurance premiums[(4)].

[(2)]The amount of inhabitants tax is calculated based on the income in the previous year in practice. Since our data sets are not panel data, however, inhabitant tax is assumed to be computed using the current income.

[(3)]We assume taxable non-labor income is 80% of non-labor income. In other words, 20% of "necessary cost" is assumed.

[(4)]We assume public pension insurance, public health insurance and public unemployment insurance as social insurance. The premiums of social insurance differ as places of work differs. The data do not contain, however, such information needed to calculate social insurance premium. We assume that the social insurance premium is 11.29% if the firm where the individual works employs less than 1000 people, 12.568% if more than 1000 people, 11.09% if the individual is a public servant. We consider the upper limit of the social insurance premium.

# 5 Results

## 5.1 Labor supply elasticity

Table 2 and 3 show our estimation results of the direct utility function (4, 5). Columns (a) to (c) are considered as different combinations of coefficient of $\delta_h$ and $\delta_w$.

[Table 2, Table 3 here]

In Table 2, most of the parameter estimates for three cases are similar. The coefficients of the linear terms, $\delta_x$, $\delta_h$ and $\delta_w$, seem to be sufficiently large compared to those of quadratic terms, suggesting that the marginal utilities of leisure and income are positive in the most of observed domain. In Table 3, though the estimated coefficients of leisure and income are negative, which may seem strange, all observations satisfy the condition that the marginal utility of income is positive. Note that the quadratic direct utility function does not impose a priori restrictions such as quasi-concavity. For both nuclear and single families, fixed cost for working is estimated statistically significantly positive (the coefficients are negative).

[Table 4 here]

The simulated elasticity of labor supply is shown in Table 4. The figures in Table 4 are sample means of the elasticities of expected labor supply with respect to the gross wage rate. The average of total elasticity of males ranges between 0.0276 and 0.0521, and that of female between 0.0429 and 0.2134, which is quite consistent with the literature. As can be expected from the positive fixed costs for working, the extensive margin elasticity is not negligible compared to the intensive margin, for both males and females. However, the relative magnitudes of the extensive margin elasticity to the intensive margin elasticity vary among specifications. Considering that we use the days worked in a year as a measure of labor supply and that using days in a year instead of hours in, say, a week generates larger elasticities, the labor supply elasticities of Japanese workers seem to be estimated quite small compared to the previous studies on Japan (Bessho and Hayashi 2010).

## 5.2 SMCF

Table 5 shows the estimated SMCF for each marginal tax rate of national income tax. The top two rows show sample average of each household's MCF$_i$, $-(\partial u_i/(\partial v_i/\partial y_i))/dR_i$, for reference, assuming that the MCF is zero if the household's behavior dose not change in response to the marginal tax reform. The SMCF, shown in the lower rows, is a twice-weighted average of $\mathrm{MCF}_i$, where the weights are the share of the household's additional tax payments, $\Delta R_i/\Delta R$, and the distributional weights, $\beta_i$. As explained in Section 3, we use three variations for $\beta_i$. Panel A shows the results when $\beta_i = 1$, Panel B is for $\beta_i = n_i$, and Panel C is for $\beta_i = \sqrt{n_i}$, where $n_i$ is the number of household members.

[Table 5 here]

The values of SMCF for increases in marginal tax rate of national income tax seem to vary from one bracket to another. If the tax system were designed efficiently, the SMCFs should be equalized among the marginal tax rates. Thus, this results might suggest that the current tax system has a room to be improved. It is true, however, that this argument bypasses the distributional aspect by ignoring neither utility nor income when computing $\beta_i$s, therefore it is possible that the current system maximizes some objective function taking equity into account.

The value of SMCF for the fourth (top) marginal tax rate in model 2 is estimated negative in all the three cases, which means that the increase in this marginal tax rate enhance the social welfare, taken at face value. On the other hand, the SMCF for the top marginal tax rate in model 3 is largest among the four marginal tax rate in all the three cases. This result suggests that the top marginal rate should be the last rate to raise. Therefore, model 2 and model 3 provide inconsistent policy implications for this point.

Let us turn to other three marginal tax rates. In five cases out of six, SMCF for the second bracket is largest among the three. When taking the number of household members into account, SMCF for the first bracket is smallest in all the cases (Panel B and C). Since smaller SMCF suggests smaller costs for raising tax rates, these results imply that raising the marginal tax rate of the first bracket is more favorable than the second and third bracket in both cases. The marginal tax rate of third bracket is applied to those with taxable annual income of 9 million yen that corresponds to before-tax income of around 15 million yen (170 thousand USD). Thus this could suggest Japanese income tax system should be less progressive.

Two points must be noted here. First, considering the progressive feature of Japanese tax system outlined in Table 1, raising the marginal tax rate in the first bracket affect the tax burden and average tax rate for those with higher income. Thus, the above-mentioned implication does not mean that the increase in tax burden of rich people should be less than those of less rich people. Second, we ignore the "distributional" concern even in Panel B and C, in the sense that only the number of household members is taken into consideration when assigning the distributional weight, $\beta_i$, to each family.

## 6 Conclusion

We investigate the effects of marginal changes of marginal tax rates of Japanese income tax system, computing the social marginal costs of public funds (SMCF) generated by marginal increase in tax rates. To calculate the SMCF we use large micro data sets on Japanese households, and estimate a structural discrete choice model of household labor supply from scratch. Our estimation results show that the average of total elasticity of males ranges between 0.0276 and 0.0521, and that of females between 0.0429 and 0.2134, which is quite consistent with the literature. Based on these estimated utility functions, SMCF for raising the marginal tax rate applied for those with medium-income level is larger than those with less income. Our results could suggest Japanese income tax system should be less progressive, raising the marginal tax rates for the lowest tax bracket.

Our analysis of course has some limitations. First, the distributional concerns are circumvented in this paper. An income tax system is usually expected to serve for income redistribution, thus distributional concerns should be taken into account in some way, though the social welfare function is subjective and basically unobservable. Second, more attention should be paid to errors associated with estimations (Creedy and Kalb 2006). The differences among SMCFs might not be significant statistically. These are topics for our future research.

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Table 1. Outline of income taxation system, 2002

(Thousand yen)

| | Income tax | Inhabitants tax |
|---|---|---|
| Basic allowance | 380 | 330 |
| Allowance for spouses | 380 | 330 |
| Special allowance for spouses | 380 | 330 |
| Allowance for dependents | 380 | 330 |
| Allowance for specific dependents | 630 | 450 |
| Employment income deduction | Not over 1,800, 40% | Not over 1,800, 40% |
| | Not over 3,600, 30% | Not over 3,600, 30% |
| | Not over 6,600, 20% | Not over 6,600, 20% |
| | Not over 10,000, 10% | Not over 10,000, 10% |
| | Over 10,000, 5% | Over 10,000, 5% |
| Lower limit | 650 | 650 |
| Tax rate | Not over 3,300, 10% | Not over 2,000, 5% |
| | Over 3,300, 20% | Over 2,000, 10% |
| | Over 9,000, 30% | Over 7,000, 13% |
| | Over 18,000, 37% | |
| Proportional tax credit | 20% | 15% |
| | Upper limit: 250 | Upper limit: 40 |

Note: The local tax rates are "the standard tax rates" set by the national law. Prefectures and municipalities are in fact allowed to charge different tax rates, but in practice, almost all local governments set the standard rates.

Table 2. Estimation results: Nuclear family

| | (a) model 1 | | (b) model 2 | | (c) model 3 | |
|---|---|---|---|---|---|---|
| Hunband's leisure (HL) | 31.270 | *** | 38.056 | *** | 38.219 | *** |
| | (1.66) | | (1.87) | | (2.02) | |
| Wife's leisure (WL) | 15.835 | *** | 18.148 | *** | 20.561 | *** |
| | (0.75) | | (0.81) | | (0.88) | |
| Family income (Y) | 3.557 | *** | 4.211 | *** | 4.815 | *** |
| | (0.75) | | (0.81) | | (0.91) | |
| $HL^2$ | -0.169 | *** | -0.174 | *** | -0.172 | *** |
| | (0.00) | | (0.00) | | (0.00) | |
| $WL^2$ | -0.056 | *** | -0.059 | *** | -0.061 | *** |
| | (0.00) | | (0.00) | | (0.00) | |
| $Y^2$ | -0.001 | ** | -0.001 | ** | -0.001 | |
| | (0.00) | | (0.00) | | (0.00) | |
| HL × Y | 0.000 | | -0.003 | * | -0.001 | |
| | (0.00) | | (0.00) | | (0.00) | |
| WL × Y | -0.005 | *** | -0.004 | *** | -0.006 | *** |
| | (0.00) | | (0.00) | | (0.00) | |
| HL × WL | 0.005 | *** | 0.007 | *** | 0.005 | *** |
| | (0.00) | | (0.00) | | (0.00) | |
| Fixed cost of husband | -9.481 | *** | -9.472 | *** | -9.464 | *** |
| | (0.17) | | (0.17) | | (0.17) | |
| Fixed cost of wife | -4.482 | *** | -4.483 | *** | -4.492 | *** |
| | (0.05) | | (0.05) | | (0.05) | |
| Age | No | | Yes | | Yes | |
| Kids | No | | Yes | | Yes | |
| Metro | No | | Yes | | Yes | |
| Education | No | | No | | Yes | |
| Log L | -102771 | | -101264 | | -100908 | |
| N | 39,616 | | 39,616 | | 39,616 | |

Note: Standard erros are in parentheses. Estimated coefficients and standard errors are presented in a 1000 times, except for the fixed cost variables. *, ** and *** represent estimated coefficients are statistically significantly different from zero at 10, 5 and 1%, respectively.

Table 3. Estimation results: Single household

| | (a) model 1 | | (b) model 2 | | (c) model 3 | |
|---|---|---|---|---|---|---|
| Leisure (L) | 11.559 | *** | 4.660 | | -1.339 | |
| | (2.93) | | (3.09) | | (3.77) | |
| Family income (Y) | 11.788 | *** | 1.539 | | -2.032 | |
| | (1.86) | | (1.96) | | (2.38) | |
| $L^2$ | -0.054 | *** | -0.060 | *** | -0.056 | *** |
| | (0.01) | | (0.01) | | (0.01) | |
| $Y^2$ | -0.003 | * | 0.003 | ** | 0.005 | *** |
| | (0.00) | | (0.00) | | (0.00) | |
| $L \times Y$ | 0.026 | *** | 0.035 | *** | 0.041 | *** |
| | (0.00) | | (0.00) | | (0.00) | |
| Fixed cost for working | -5.645 | *** | -5.657 | *** | -5.653 | *** |
| | (0.17) | | (0.17) | | (0.17) | |
| Age | No | | Yes | | Yes | |
| Sex | No | | Yes | | Yes | |
| Metro | No | | Yes | | Yes | |
| Education | No | | No | | Yes | |
| Log L | -15792 | | -15529 | | -15515 | |
| N | 13,090 | | 13,090 | | 13,090 | |

Note: Standard erros are in parentheses. Estimated coefficients and standard errors are presented in a 1000 times, except for the fixed cost variables. *, ** and *** represent estimated coefficients are statistically significantly different from zero at 10, 5 and 1%, respectively.

Table 4. Wage elasticities

| | Nuclear family | | | | Single | |
|---|---|---|---|---|---|---|
| | Change in own wage rate | | Change in spouse's wage rate | | Change in own wage rate | |
| | Model 2 | Model 3 | Model 2 | Model 3 | Model 2 | Model 3 |
| Male | | | | | | |
| total | 0.0276 | 0.0329 | 0.0017 | 0.0019 | 0.0285 | 0.0521 |
| extensive | 0.0126 | 0.0155 | 0.0006 | 0.0007 | 0.0004 | 0.0316 |
| intensive | 0.0150 | 0.0174 | 0.0011 | 0.0012 | 0.0281 | 0.0204 |
| Female | | | | | | |
| total | 0.1589 | 0.2134 | 0.1315 | 0.2411 | 0.0429 | 0.2203 |
| extensive | 0.1199 | 0.1589 | 0.1058 | 0.1946 | 0.0026 | 0.1954 |
| intensive | 0.0389 | 0.0545 | 0.0257 | 0.0464 | 0.0403 | 0.0247 |

Table 5. SMCF of raising marginal tax rates

| | 1st bracket | 2nd bracket | 3rd bracket | 4th bracket |
|---|---|---|---|---|
| Original rates | 10% | 20% | 30% | 37% |
| Average of $MCF_i$ | | | | |
| model 2 | 1.1146 | 0.6196 | 0.0220 | -0.0203 |
| model 3 | 1.1781 | -19.38 | -19.90 | -19.92 |
| A. SMCF: $\beta_i = 1$ | | | | |
| model 2 | 1.1489 | 1.2835 | 1.1177 | -0.7547 |
| order | **3** | **4** | **2** | **1** |
| model 3 | 1.1984 | 1.3210 | 1.1919 | 1.4733 |
| order | **2** | **3** | **1** | **4** |
| B. SMCF: $\beta_i = n_i$ | | | | |
| model 2 | 3.1761 | 3.9559 | 3.9094 | -3.2371 |
| order | **2** | **4** | **3** | **1** |
| model 3 | 3.3222 | 4.0955 | 4.2404 | 5.5330 |
| order | **1** | **2** | **3** | **4** |
| C. SMCF: $\beta_i = n_i^{1/2}$ | | | | |
| model 2 | 1.8487 | 2.2013 | 2.0653 | -1.5837 |
| order | **2** | **4** | **3** | **1** |
| model 3 | 1.9314 | 2.2737 | 2.2234 | 2.8204 |
| order | **1** | **3** | **2** | **4** |